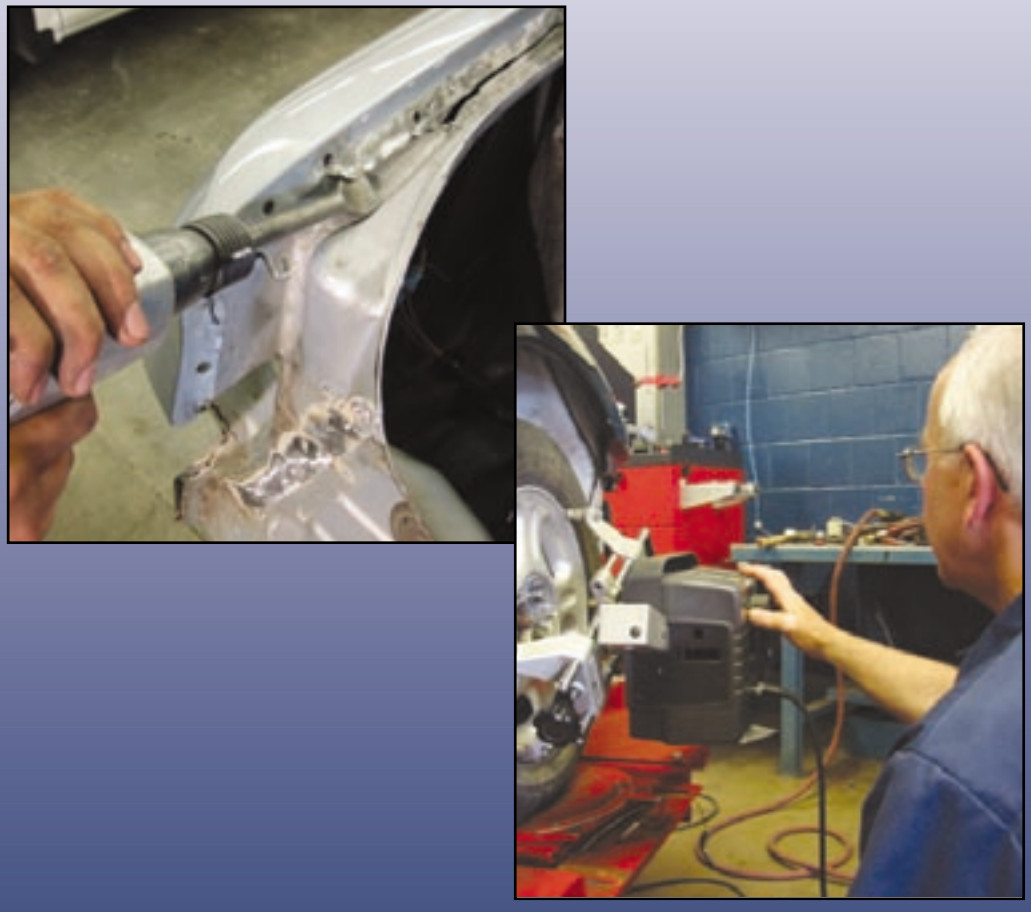
AUTO BODY REPAIR

WELDING



TEACHER'S GUIDE

SHOPWARE®

INTRODUCTION

This Teacher's Guide provides information to help you get the most out of *Welding.* The contents in this guide will enable you to prepare your students before using the program and present follow-up activities to reinforce the program's key learning points.

As part of the 12-part series *Auto Body Repair*, *Welding* introduces basic welding concepts related to collision repair, including different types of fusion welding, the setup and functionality of the welding gun, types of weld joints and how to make and test them, and safety precautions to practice when welding. After viewing this video, students will have a more detailed understanding of welding equipment and techniques used in collision repair, and safety precautions to take when performing welding tasks. Use the *Welding* video and accompanying activities provided in this guide to teach students basic welding techniques, setting up the welding gun and metal assemblies prior to welding, and welding safety practices.

LEARNING OBJECTIVES

After viewing the program, students will be able to:

- Identify different types of welds.
- Explain MIG Welding techniques.
- List considerations for planning a weld.
- Identify the correct tools to use given the task to be performed.
- Demonstrate a basic knowledge of welding operations and safety procedures.
- Summarize proper preparations for welding.

EDUCATIONAL STANDARDS

The primary certifying body for automotive technician training programs is the National Institute for Automotive Service Excellence (ASE). ASE is a non-profit organization established in 1972 by the automotive industry to improve the quality of vehicle repair and service through the voluntary testing and certification of automotive repair technicians. The National Automotive Technicians Education Foundation (NATEF) is a separate non-profit foundation within ASE. The mission of NATEF is to improve the quality of automotive technician training programs nationwide through voluntary certification. The State Departments of Education in all 50 states support ASE/NATEF certification of automotive programs.

National Standards

This program correlates with the Program Certification Standards for Automobile Technician Training Programs from the National Institute for Automotive Service Excellence (ASE) and the National Automotive Technicians Education Foundation (NATEF). The content has been aligned with the following educational standards, which reflect the tasks in the ASE Program Certification Standards for Automobile General Service Technician Programs.

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Metal Welding

- Determine correct welding process in accordance with vehicle manufacturer's / industry's recommendations (GMAW [MIG], squeeze-type resistance spot), electrode, wire type, diameter, and gas to be used in specific welding situations.
- Set up and adjust welding equipment for the material to be welded (steel, aluminum).
- Determine proper welding technique (push, pull, and gun angle) for the type of welds being made.
- Identify the type of weld joint (butt, lap, etc.) for the repair being made.
- Use the proper gun-to-joint angle, and direction of gun travel, for welds being made in all positions.
- Determine the correct type of weld (continuous, stitch, skip, plug, spot, etc.) and preparation for each specific welding operation.
- Identify the causes of welding defects (burn through, cracks in metal, porosity, improper penetration, excessive splatter, distortion, and waviness of bead,); make necessary adjustments.
- Insure proper work clamp (ground) location.
- Prepare the metal to be welded; assure good metal fit-up; apply weld-through primer, if necessary.
- Perform test welds. Visually inspect and perform destructive test.
- Protect vehicle systems and components, including computers, other electronic modules, adjacent panel and glass from possible damage during welding and cutting operations.
- Identify safety considerations: Eye protection, proper clothing, respiratory protection, shock hazards, fumes, material safety data sheet (MSDS), etc. before beginning any welding operation.

2004 Automobile Program Standards, by the National Institute for Automotive Service Excellence (ASE), Copyright 2004 Reprinted with permission.

Language Arts and Communication Standards

According to ASE/NATEF standards, the automobile technician must be proficient in the following Language Arts and Communications related academic skills that are embedded in the occupation. The activities and information presented in this program and accompanying teacher's guide are aligned to the following standards from the National Automotive Technicians Education Foundation from the National Institute for Automotive Service Excellence.

- Request, collect, comprehend, evaluate, and apply oral and written information gathered from customers, associates, and supervisors regarding problem symptoms and potential solutions to problems.
- Identify the purpose for all written and oral communication and then choose the most effective strategies for listening, reading, speaking, and writing to facilitate the communication process.
- Adapt a reading strategy for all written materials, e.g. customer's notes, service manuals, shop manuals, technical bulletins, etc., relevant to problem identification, diagnosis, solution, and repair.
- Use study habits and techniques, i.e. previewing, scanning, skimming, taking notes, etc., when reviewing publications (shop manuals, references, databases, operator's manuals, and text resources) for problem solving, diagnosis, and repair.

- Write clear, concise, complete, and grammatically accurate sentences and paragraphs.
- Write warranty reports and work orders to include information regarding problem resolution and the results of the work performed for the customer or manufacturer.
- Follow all oral/written directions that relate to the task or system under study.
- Comprehend and apply industry definitions and specifications to diagnose and solve problems in all automotive systems and components of the automobile and light truck.
- Comprehend and use problem-solving techniques and decision trees that are contained in service manuals and databases to determine cause-and-effect relationships.
- Use the service manual to identify the manufacturer's specifications for system parameters, operation, and potential malfunctions.
- Supply clarifying information to customers, associates, parts supplier, and supervisors.

Technology Standards

The activities in this Teacher's Guide were created in compliance with the following *National Education Technology Standards* from the National Education Technology Standards Project. The content has been aligned with the following educational standards and benchmarks.

- Use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
- Use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- Use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
- Use technology tools to enhance learning, increase productivity, and promote creativity.
- Use technology to locate, evaluate, and collect information from a variety of sources.

The *National Education Technology Standards* reprinted with permission from the International Society for Technology Education.

PROGRAM OVERVIEW

The ability and knowledge to weld properly is one of the most useful skills an auto body technician can master. A top quality weld is the foundation of professional collision repair. This video, *Welding*, offers a behind-the-scenes look at the welding process in a collision repair facility. Viewers will closely examine the functionality of the various parts of the MIG welding gun, the most commonly used welding gun for auto body repair today, and the method to set up the equipment prior to use. The different types of collision repair welding techniques and weld joints will be explored, including when to use them, potential problems, and quality testing. Viewers will also learn important safety precautions to practice in order to protect their body and surrounding property when performing welding tasks.

MAIN TOPICS

Topic 1: Types of Fusion Welding
This section of the program introduces the concept of welding, and the different types of fusion welding, including their suitability for collision repair.

Topic 2: MIG Welder Setup and Functionality
This section of the program describes how to set up a MIG (metal inert gas) welder, the type of welder most often used in auto body repair, and how it works. Students will learn the primary parts of the welder and the function of each component, and the ways in which travel speed, direction, and gun angle affect the quality of a weld.

Topic 3: Types of Weld Joints and Welding Techniques
This section of the program describes types of weld joints and how to form them using the welding gun. Students will learn the factors that determine when to use each type of weld joint.

Topic 4: Practice Welds and Destructive Testing
This section of the program describes the importance of practicing welding techniques and the destructive testing method used to determine the quality of the weld.

Topic 5: Safety Practices
In this section, students will learn the significance of protective clothing, and the necessary precautions to take when performing welding tasks to avoid bodily injury and damage to nearby property.

FAST FACTS

- Welding is a process where heat is applied to two pieces of metal to fuse them together. In many cases, additional filler material from a wire or rod is added to help complete the weld joint.
- Most of today's vehicle frames are built in one piece, called a unibody, which is constructed by welding, bolting, and adhesive-bonding the various body parts together.
- MIG welding is the ideal welding process for collision repairs because it concentrates the heat in a narrow area; the welds performed on unibody frames during collision repairs must achieve100 percent fusion in order to maintain their structural strength.
- When the welding gun trigger is pressed, an electrical current passes from the contact tube to the automatically-fed electrode wire, creating a small arc between the wire and the layers of base metal to be welded. The heat from the arc melts the wire and fuses it together with the layers of base metal, while flowing shielding gas isolates the weld from contaminants in the air. Once it cools the wire and base metals are completely fused together at the joint, creating one solid piece of metal.
- .023 [Oh-two-three] wire, a special wire used for auto body repair, is made of a high-grade steel alloy that has a tensile strength of 70,000 pounds. As it melts, it helps fill in the joint, adding strength to the weld.

- To set up the MIG welder, reference the operating manual to: (1) set up the wire feed mechanism for .023 wire; (2) hook the gas supply to the welder; (3) set the gas regulator on the gas supply to control speed of the gas flow for 0-2-3 wire; (4) set the amperage (heat and voltage) and wire speed for 0-2-3 wire; (5) choose the polarity (direction of current); and (6) plug the welder into a 110 or 220 grounded outlet.
- Variables that affect the quality of a weld are travel speed, travel direction, and gun angle.
- The seven basic types of weld joints are tack, spot, plug, butt, reinforced butt, lap, and a fillet weld.
- The type of weld to use is determined by the location of the joint on the vehicle and whether the repair area is structural or non-structural.
- The steps to prepare for a weld are: (1) prepare the surface by removing paint, undercoatings, rust, dirt, oil and grease; (2) apply a weld-through primer to the surfaces to be welded and areas immediately adjacent to protect against corrosion in weld zones; and (3) chemically clean the area to be welded.
- Since MIG welders reach a temperature approaching 9,000 degrees Fahrenheit and produce ultraviolet light (the same light that causes sunburn), proper protection is critical!
- Proper safety clothing and equipment include a welding hood with #10 shade to protect against blinding light; leather gloves to protect against metal cuts and sparks; non-flammable long sleeves and pants without cuffs that can trap sparks (jumpsuit preferred); leather vests for welding overhead; and work boots.
- Practice safety in the shop by covering adjacent equipment and car parts to protect property from flying sparks.
- Practice safe MIG welder operation by avoiding wet floors; checking fraying on cords/cables; keeping the welder within reasonable distance of the welding site; and ensuring the MIG set up follows all operator manual specifications.
- The grounding cable from the welder must be clamped to bare metal on the same panel that is being welded as close as possible to the weld point to complete the electrical circuit for the welder and enable the current to flow.
- Apprentice welders should practice making weld joints and then destroying them. Destructive testing is intended to determine the strength and penetration of the weld to see if it was done correctly. A good weld joint is one that tears apart when destroyed; a weak weld joint is one that simply breaks apart with little or no tearing.

VOCABULARY TERMS

amperage: The voltage on the MIG welder that typically uses the wire feed speed to control the amount of heat at the arc. Since the heat remains relatively constant, the weld beads produced are usually uniform in shape and size. “Current” is another name for amperage.
argon gas: An inert gas found in shielding gas used in MIG welding that protects the weld from contaminants. Typically combines with the steel in the joint and makes a stronger, cleaner weld.
burn-through: A condition that occurs when the welding gun is moved too slowly or held in place for too long, causing the weld bead to melt too far down into the joint and burn through the other side of a steel panel, which reduces the strength of the weld joint. (The slower the weld gun is moved, the deeper the weld penetration.)

butt weld: A type of weld that is used to join two metal parts aligned in the same plane (butting up against one another) by filling the gap between the two metal parts.
contact tube: A tube on a welding gun, usually made of copper or copper alloy that conducts electricity.
direct current: An electrical current that flows in one direction only.
electrode wire: Part of the welding gun that must be in contact with the base metal to complete the electrical circuit and start the welding process.
fillet weld: A type of weld that joins two pieces at right angles to one another with a continuous weld bead or with spot welds.
full penetration: A condition that occurs when the MIG welding gun is held in place just long enough, causing the weld fusion to penetrate through the full thickness of the base metal, but not so far as to burn through the other side. Typically characterized by a low profile weld bead.
fusion: Heating materials to be joined to their melting point, so that the molecules of the metals actually combine.
gas nozzle: A component that fits on the tip of the welding gun, which directs the flow of shielding gas to the weld.
gas regulator: Component on the gas supply that controls the speed of the shielding gas flow in MIG welding.
inert: Not combining readily with other elements; a property of argon gas.
lap weld: A type of weld that is formed when two pieces of metal overlap and are welded together, front and back, by running a continuous weld bead or spot welds along the joints.
stitch a weld: A technique used to prevent metal from overheating by pausing between welds to allow the metal to cool.
metal inert gas (MIG) welding: (Also called **"**gas metal arc welding" or "wire-feed welding"). A type of gas metal arc welding process that automatically feeds wire (the metal) through the welding tip into the weld while using shielding gases to protect the metal against corrosion during the welding process. MIG welding is ideal for collision repair on high strength steel because it happens in a microsecond, preventing the metal surrounding the weld joint from heating up, and because it achieves 100 percent fusion. Can be used to weld metals other than steel, such as aluminum, but requires different wire, shielding gas, and settings.
.023 (oh-two-three) wire: A type of special wire that is made of a high-grade steel alloy that has a tensile strength of 70,000 pounds. As it melts, it helps fill in the joint, adding strength to the weld. .023 wire can be used on all thicknesses of steel during auto body repairs.
oxyacetylene welding: A fusion welding process which uses a mixture of oxygen and acetylene gas that is slow to reach the melting temperature of steel, but heats up the metal in areas adjacent to the weld, causing warping and loss of structural strength. For this reason, it is no longer recommended for most collision repairs, but can be used for metal cutting, fastener removal, and heat cleaning.
plug weld: A type of weld that is used to weld two or more base metals together by drilling small holes (8 millimeters to >1/4 inch) that get progressively smaller, and filling them with short bursts from the outside working inward to ensure fusion of each layer.
polarity: The direction of the flow of current in a circuit. In collision repair, reverse polarity or direct current (DC) reverse is typically used because it provides the best fusion, due to a more stable arc.

pulling the weld: A welding technique where the tip of the weld gun is angled toward the weld puddle as the gun is moved along the seam being welded. Pulling the weld requires a slower travel speed than pushing.
pushing the weld: A welding technique where the tip of the weld gun is angled away from the weld puddle as the gun is moved along the seam being welded. Pushing the weld requires a faster travel speed than pulling, and is more prone to burn-through.
reinforced butt weld: A variation of a butt weld that is formed by inserting another piece of metal (same as that being welded) behind the joint and running a continuous weld joint down the face of the joint, fusing the insert to the other panels.
resistance spot welding (pressure welding): A welding process that heats metal by an electric current passing through the arms of the welder until the metal is softened, and then fuses the metal pieces together using the two metal arms to apply pressure to both sides of the metal panels being welded. Typical characteristics are small, round weld beads. Most often used during the vehicle manufacturing process; less commonly used in collision repair due to restricted access to both sides of the panels being welded.
shallow penetration: A condition that occurs when the MIG welding gun is removed too quickly from the weld panel. There is virtually no weld bead. After grinding off the weld bead, there is little left to hold these two pieces of material together, resulting in a weak weld.
shielding gas: A type of gas that flows through a MIG weld gun tip during the welding process that isolates the weld from contaminants in the general atmosphere. C-25 shielding gas is a 75-25 mixture of argon and carbon dioxide that is typically used in MIG welding.
simple butt weld: A variation of a butt weld that is formed by holding the weld gun at a 90 degree angle and moving it along the joint to create one continuous weld. Is most often used in areas that do not require structural strength (sectioning repairs on rocker panels and door posts).
spot weld: A type of weld that is used to fuse the top metal to the bottom without pre-drilling a hole. A spot weld is made by holding the welding gun at a 90-degree angle from the base metals to be welded. This weld type is not strong or consistent.
tack weld: A type of weld that uses small weld beads to hold the pieces of metal in proper alignment temporarily until the final welds are made. Enables the welder to determine if all pieces fit,
tungsten inert gas (TIG) welding: A type of gas metal arc welding process that is often used in engine repair.
weld bead: A weld deposit produced by a single pass during one of the welding processes.
weld joint: The joining of two or more metal parts by welding.
welding: A process of applying heat to two pieces of metal to fuse them together. Often, additional filler material from a wire or rod is added to help complete the weld joint.
weld puddle: The accumulation of molten welding metal within a weld joint.

PRE-PROGRAM DISCUSSION QUESTIONS

1. What is welding? Why is it used? And what does it accomplish?
2. Have you seen someone weld something–either in person or on television? If so, what were they welding? What type of tools and equipment were they using?
3. Many of the things we use in our daily lives are welded or made with welding equipment. What are some everyday items or structures that are constructed using a welding process?
4. What welding equipment is used when performing collision repairs?
5. Safety is important when performing welding tasks. What safety measures should welders practice within the auto body repair shop?

POST-PROGRAM DISCUSSION QUESTIONS

1. Now that you have seen the *Welding* video, explain why MIG welding is the ideal welding process for collision repairs.
2. What are the three variables that affect the quality of a weld?
3. As a group, list the seven basic types of weld joints, and identify when each one is used.
4. What are some of the considerations welders should think about when planning a weld?
5. In your opinion, what is the most critical element of perfecting the art of welding?

GROUP ACTIVITIES

What's Wrong With This Picture?
Using poster paper, sketch the area of an auto body repair shop where welding tasks are performed. Title the poster heading "What's Wrong With This Picture?" Using the safety precautions that were presented in the video, include 8 - 10 examples of dangerous procedures or inadequate safety measures. For example, draw a welder who is not wearing the proper clothing or welding hood. You may research welding safety measures online for additional ideas. Color the poster using colored markers or pencils. Present the poster to the class by asking the students to inspect the poster (in groups of three), and to write down their observations. Stress that this exercise is to be done silently! After all students have had the opportunity to study the poster and record their findings, ask volunteers to name one observation on their list until all examples of inadequate safety measures have been revealed.

Design a Quiz Show Game
As a group, prepare five questions and their corresponding answers related to the following four categories: MIG Welder Set Up; Weld Joints; Welding Techniques; Safety Practices (there will be a total of 20 questions and answers). Assign a point value to each of the five questions within each category ranging from 100 to 500 points. The level of difficulty should increase with the point value.

Designate individuals to play the role of the MC, Scorekeeper, and Game Technician. The MC will read the game instructions, categories, questions, and make final determinations of the accuracy of each response; the Scorekeeper will keep score by adding and subtracting points; and the Technician will either navigate within the computer-based gaming application, or in the case of a non-computer format, the Technician will erase the point value of each question on the board to indicate the question was chosen.

Option #1: Create a PowerPoint presentation that includes the questions, answers, and point values. You can consult a Web site to access a PowerPoint template designed for this type of game: http://languagecenter.cla.umn.edu/index.php?page=forum_jeopardy

Option #2: Draw the game board on the chalkboard as shown below.

MIG Welder Set Up	Weld Joints	Welding Techniques	Safety Practices
$100	$100	$100	$100
$200	$200	$200	$200
$300	$300	$300	$300
$400	$400	$400	$400
$500	$500	$500	$500

Instructions

- Divide the class into two teams and instruct each team to choose a name. Write the team names on the chalkboard for scorekeeping purposes.
- The instructor will select and read aloud the $100 question in the first category to begin the game.
- The first person to raise his/her hand on either team will be given the opportunity to answer the question.
- If a player answers a question correctly, his/her team will earn points. Likewise, if a player answers a question incorrectly, his/her team will lose points.
- Any team member will be permitted to answer questions that were initially answered incorrectly, but neither team will earn points.
- The player who answered the previous question correctly will select a new category and amount. If the question was answered incorrectly, the other team will select a new category and amount.
- The game continues in this fashion until all questions have been answered. The team with the most points wins.

Welding Considerations Checklist

As a group, prepare a checklist of considerations auto body repair technicians should initially think about when planning a weld. Consult the *Welding* video, the Internet, and any other sources that you have available. Think about different welding tasks and create a checklist of factors auto body repair technicians should consider before beginning a welding task. Consider the following topics: MIG welder set-up; Joint location; Structural vs. Non-structural Weld; Task Steps; Types of Weld Joints (and when to use them); Pre-preparation of Steel Material; Safety Precautions.

Create a one-page job aid in the form of a checklist that lists pre-welding considerations to help apprentice auto body repair technicians prepare for a welding task. For example, the checklist could include the following items noting tasks and sub-tasks:

- ❒ *Set up the MIG welding gun for steel according to the operating manual specifications*
- ❒ *Set up the wire feed mechanism for .023 wire*

Create a logo or insert graphics to jazz up the job aid. Include blanks check boxes for additional tasks to be filled in later by students. Be prepared to share your checklist with the class. *Optional:* Make copies of the checklist and distribute to fellow classmates.

INDIVIDUAL STUDENT PROJECTS

Welding Joints Match Game

The *Welding* video describes the following seven basic types of weld joints: Tack, Spot, Plug, Butt, Reinforced Butt, Lap, and Fillet. Obtain two pieces of poster board. On one poster board at approximately three inches down from the top draw two columns of the same size, and then divide these columns into eight rows. Label the first row in the left column *Weld Joint* and label the first row in the right column *Description*. Using the second piece of poster board, cut out and glue/tape a rectangle in each row in the right column to form a pocket, for a total of seven pockets. Letter the pockets A through G.

Research the types of weld joints using the Internet or library resources. Then, draw and identify a simple picture of each type of weld joint in the left column. Using the second piece of poster paper, cut out seven squares that are slightly smaller than the pockets. For each weld joint, briefly describe its purpose and/or when it should be used **without** identifying the weld joint by name. For example, a description for a tack weld joint might read: *This type of weld joint uses small weld beads to temporarily hold the pieces of sheet metal in place until the final welds are made. Enables the welder to determine if all pieces fit.* The object of the game is to match each description to the correct welding joint by placing the correct descriptive card in the pocket that is located across from the corresponding graphic. Write the letter of the weld joint on the BACK of each descriptive card to indicate its correct matching pocket.

Again, using the second piece of poster paper, create a large pocket that is capable of holding all of the descriptive cards. Attach this pocket to the bottom of the first poster to store the cards. At the top of the poster, write brief instructions for playing the game. Invite classmates to challenge themselves by playing the Welding Joints Match Game!

Interview a Welder

What is a typical day like for a welder? One way to learn about the profession is to visit a local auto body repair shop and speak with an experienced auto body repair professional. Contact (call or visit) a local auto body repair establishment and ask if they could arrange a 15-minute interview for you to speak with an auto body repair professional who has comprehensive experience in the field of welding. Inform them of the purpose of your request.

Prepare a set of open-ended questions to ask the auto body technician during the interview. You may use the following questions:

- Which welding technique or weld joint is easy to master, and why? Which is hard to master, and why?
- What aspects of MIG operation do new welders often overlook?
- In your opinion, what do you think is the most challenging aspect of welding?
- What is a typical day like for you?
- What, if any, new technologies or equipment are being introduced that will improve the quality of weld joints and/or the welding process in general?
- After completing your research, prepare a presentation about your discussion with the auto body repair technician. You may share your findings with the class by presenting an oral report or a PowerPoint presentation.

Welding Technology

The video described the MIG welding process and why it's the most popular choice for collision repair. The buzz today is about new welding technologies involving laser and automated welding. Research new welding technologies on the horizon using the Internet, including Discussion Forums, or reference industry publications, automotive welding professionals, etc., and write a brief one-page paper about the potential advantages and disadvantages of the new technologies over the MIG welding process.

INTERNET ACTIVITIES

Scavenger Hunt

There are various resources on the Internet that provide information about welding in an auto body repair environment. Using a search engine, type in key words that will help you find current information and Web sites that are useful to your search. Some search terms you may want to use to get started include: *welding basics* and *MIG welder*. Create a handout on five of the web sites you found. This handout should list the Web sites related to automotive welding, and a brief description of the reasons why you would recommend them to your fellow classmates.

Automotive Certification Research

The primary certifying body for automotive technician training programs is the National Institute for Automotive Service Excellence (ASE). The National Automotive Technicians Education Foundation (NATEF) is a separate non-profit foundation within ASE. Both entities have a specific purpose regarding automotive technician training programs nationwide. Using a search engine (such as Yahoo! or Google), research each organization. Then, write a one-page summary of your findings regarding the mission, history, fundamentals, and benefits of each organization. Be prepared to discuss your findings with the class.

Discussion Forums

Visit www.autobodyonline.com and enter the discussion forums by clicking the "Discussion" tab in the upper left corner of the web page. Post a question about welding techniques, weld joints, or the MIG welding gun. Ask about the nuances that experienced auto body repair technicians should be aware of when approaching welding for the first time. Also, review the other posts within the forums and see if you can gather any other information about welding in the collision repair business. After a week, copy all your responses, as well as any other posts you have seen that are relevant, into a word processing document. Then answer the following questions: What have you learned as a result of the answers you have received to your post? What have you learned from reading other posts? Did any of the responses conflict with one another? If so, what issues did they raise?

ASSESSMENT QUESTIONS

Q: Technician A says that oxyacetylene welding has limited use in collision repair. Technician B says that MIG welding is the only ideal welding process for collision repairs. Who is correct?

(a) Technician A
(b) Technician B
(c) Both A and B
(d) Neither A nor B

A: (c)

Feedback: MIG welding is used for general collision repairs because it concentrates the heat in a narrow area and the welds achieve100 percent fusion. Oxyacetylene welding can also be used in the collision repair process, but it is limited to metal cutting, fastener removal, and heat cleaning. Because it's slower than MIG welding, it's a good choice for practice in getting used to the welding process.

Q: Which one of the following variables does NOT affect the quality of a weld?

(a) Weld penetration
(b) Travel speed
(c) Travel direction
(d) Welding gun angle

A: (a)

Feedback: Variables that affect the quality of a weld are travel speed, travel direction, and gun angle. Weld penetration is related to travel speed caused by moving the MIG welding gun too fast, too slow, just right, or holding the gun in place for too long. There are varying degrees of penetration.

Q: When conducting destructive testing to determine the strength and penetration of the weld, which one of the following is characteristic of a good weld joint?

(a) The weld joint breaks apart with little or no tearing
(b) The weld joint tears apart when destroyed
(c) The weld joint is invisible to the naked eye
(d) The weld joint crumbles in tiny pieces

A: (b)
Feedback: Apprentice welders should always practice making weld joints and then destroying them. Destructive testing is intended to determine the strength and penetration of the weld to see if it was done correctly. A good weld joint is one that tears apart when destroyed; a weak weld joint is one that simply breaks apart with little or no tearing.

Q: Which component on the gas supply controls the speed of the shielding gas flow in MIG welding?

(a) Gas nozzle
b) Gas regulator
(c) Electrode wire
(d) Contact tube

A: (b)
Feedback: The gas regulator is the component on the gas supply that controls the speed of the shielding gas flow in MIG welding. The gas nozzle, electrode wire, and contact tube are parts of the welding gun that are not related to the speed of the shielding gas flow on the gas supply.

Q: Once the MIG welder is properly set up, auto body repair technicians should not have to alter the settings for collision repair as long as they are welding steel. *(True or False)*
A: True
Feedback: Most work in collision repair involves welding steel. Once the MIG welder is properly set up, auto body repair technicians should not have to alter the settings for collision repair as long as they are welding steel. Technicians can set up a MIG to weld metals other than steel, such as aluminum, but different wire, shielding gas, and settings are required according to the manufacturer's specifications.

Q: Technician A says that the primary purpose of the grounding cable from the welder is to complete the electrical circuit for the welder and enable the current to flow. Technician B says that the primary purpose of the grounding cable from the welder is to hold parts that are being welded together so they don't move during the welding process. Who is correct?

(a) Technician A
(b) Technician B
(c) Both A and B
(d) Neither A nor B

A: (a)
Feedback: Grounding cable from the welder must be clamped to bare metal on the same panel that is being welded as close as possible to the weld point to complete the electrical circuit for the welder and enable the current to flow. This grounding cable can be used to clamp the parts that are being welded together so they don't move during the welding process, but that is not its primary purpose.

Q: Before welding on a vehicle, auto body technicians should _____.
A: Make a practice weld
Feedback: Before welding on a vehicle, auto body technicians should make a practice weld on the same material and in the same position that will be used for the final weld.

Q: Which of the following is a condition that occurs when the MIG welding gun is removed too quickly from the weld panel, resulting in virtually no weld bead?

(a) Full penetration
(b) Burn-through
(c) Polarity
(d) Shallow penetration

A: (d)
Feedback: Shallow penetration is a condition that occurs when the MIG welding gun is removed too quickly from the weld panel, resulting in virtually no weld bead. After grinding off the weld bead, there is little left to hold these two pieces of material together, resulting in a weak weld.

Q: What type of safety clothing and equipment should auto body repair professionals wear when performing welding tasks?
A: Welding hood with #10 shade; leather gloves; non-flammable long sleeves and pants without cuffs; leather vests; and work boots.
Feedback: Proper safety clothing and equipment include a welding hood with #10 shade to protect against blinding light; leather gloves to protect against metal cuts; non-flammable long sleeves and pants without cuffs that can trap sparks (jumpsuit preferred); leather vests for welding overhead; and work boots.

Q: The type of weld to use is determined by the location of the joint on the vehicle and whether previous repairs were made to the repair area. *(True or False)*
A: False
Feedback: The type of weld to use is determined by the location of the joint on the vehicle and whether the repair area is structural or non-structural.

ADDITIONAL RESOURCES

WEB SITES

Auto Body Online
www.autobodyonline.com

Auto Body P.I.
www.autopi.com/frame.htm

Auto Body Pro
www.autobodypro.com

Auto Body Tool Mart Repair and Restoration Tutorials
www.autobodytoolmart.com/restorations.html

Automotive Body Repair News
www.abrn.com/abrn

Auto Glossary
www.autoglossary.com

Collision Repair Industry: Insight
http://www.collision-insight.com

How Stuff Works—Auto Stuff Page
http://auto.howstuffworks.com

I-car
www.i-car.com

National Automotive Service Task Force
www.nastf.org

National Automotive Technicians Education Foundation
www.natef.org

Tektips - Auto Body Pro Website
www.autobodypro.com/tektips.htm

The Welding Institute
http://www.twi.co.uk/j32k/index.xtp

Welding
http://www.welding.com

BOOKS

Duffy, James E. *I-CAR Professional Automotive Collision Repair*. Albany, NY: Delmar / Thomson Learning, 2001. ISBN: 0766813991

Duffy, James E. *Auto Body Repair Technology, 4th Edition*. Clifton Park, NY: Thomson / Delmar Learning, 2003. ISBN: 0766862747

Killingsworth, Jeff, Eric Godfrey, and John H. Haynes. *The Haynes Suspension, Steering And Driveline Manual*. Newbury Park, CA: Hayes North America, 1998. ISBN: 1563922932

OTHER PRODUCTS

Automotive Technicians, VHS/DVD, Cambridge Educational
Sponsored by the National Automotive Technicians Education Foundation (NATEF), this program explores automobile repair and collision repair. NATEF works closely with Automotive Service Excellent (ASE), the nation's only industry-wide certification program for automotive technicians. Technicians with a sound education have a choice of career avenues. Aside from fixing cars and trucks, they can become service managers, service engineers, automotive writers, or even auto technology teachers.
Order #: 24924, www.cambridgeeducational.com, 1-800-468-4227

Introduction to Welding, VHS/DVD, Meridian Education
This four-part, live-action series introduces viewers to four major welding areas: Oxyfuel, Shielded Metal Arc, Gas Tungsten Arc, and Gas Metal Arc/Flux Core Arc. Each video includes welding definitions, welding components, safety equipment, assembly and use of the system, and the types and kinds of welds. Safety procedures are emphasized throughout, including the proper clothing, equipment, and filter lens required for the job. This series provides an excellent overview of the welding field and clearly demonstrates proper technology in each area.
Order #: 25686, http://www.meridianeducation.com, 1-800-727-5507

Metal Shop Safety, VHS/DVD, Meridian Education
This program is a fast-paced, informative video that demonstrates the kind of precautions that should be taken when working with metals. Sheet metal work, soldering, welding, foundry work, forging, and general safety are summarized. Footage of actual fatal accidents is used to strengthen the importance of safety in the metals lab. Watch what happens when molten metal is spilled on water, when it explodes, and when molten aluminum is spilled on a non-protective tennis shoe. This metal working safety video should be viewed by anyone studying technology or any metal working trade. *Metal Shop Safety* is one of a four-part series that explains the need for safety procedures, as well as precautions that can be taken to ensure a safe working environment. The series also includes *Auto Shop Safety, Electrical Safety,* and *Shop Safety*.
Order #: 25897, http://www.meridianeducation.com, 1-800-727-5507

Multimedia Welding Safety, CD-ROM, Shopware
This multimedia CD-ROM examines not only the welding process itself, but also safety practices. Through a combination of schematic diagrams, video and animation sequences, and still photos of tanks, regulators, and gauges, welding makes sense, even to the novice. The user is led to explore topics including welding torches, resistance spot welding, arc welding, and wire-feed welding. Navigation through the program is user-friendly, with options that allow users to review or bypass lesson segments. A teacher's utilities section is also included, allowing teachers to monitor student performance and completion of lesson materials. *Multimedia Welding Safety* is one of a four-part series that explains safety procedures and precautions in a working environment. The series also includes *Multimedia Electrical Safety, Multimedia Auto Shop Safety,* and *Multimedia Woodshop Safety*.
Order #: 20461, http://www.cambridgeeducational.com, 1-800-468-4227

Safety First: Welding Shop Safety VHS/DVD, Cambridge Educational
This program examines specific protective gear for welders in detail, the proper way to store tanks, hoses, gauges, and cutting/brazing torches, and the basics of testing lines for leaks, attaching gauges to tanks, and adjusting pressure settings to proper levels. This program also discusses a variety of welding processes, including MIG, TIG, and oxyacetylene, and the most common concerns of welders, including proper grounding of the machine and the work piece, correct applications of commercial gases, and maintaining weld tips. Viewers will also realize the necessity of a positive attitude and concentration when performing welding tasks. *Safety First: Welding Shop Safety* is one of a four-part series that explains the need for safety procedures, as well as precautions that can be taken to ensure a safe working environment. The series also includes *Electrical Safety, Safety First: Woodworking Safety,* and *Safety First: Auto Shop Safety*.
Order #: 14465, http://www.cambridgeeducational.com, 1-800-468-4227

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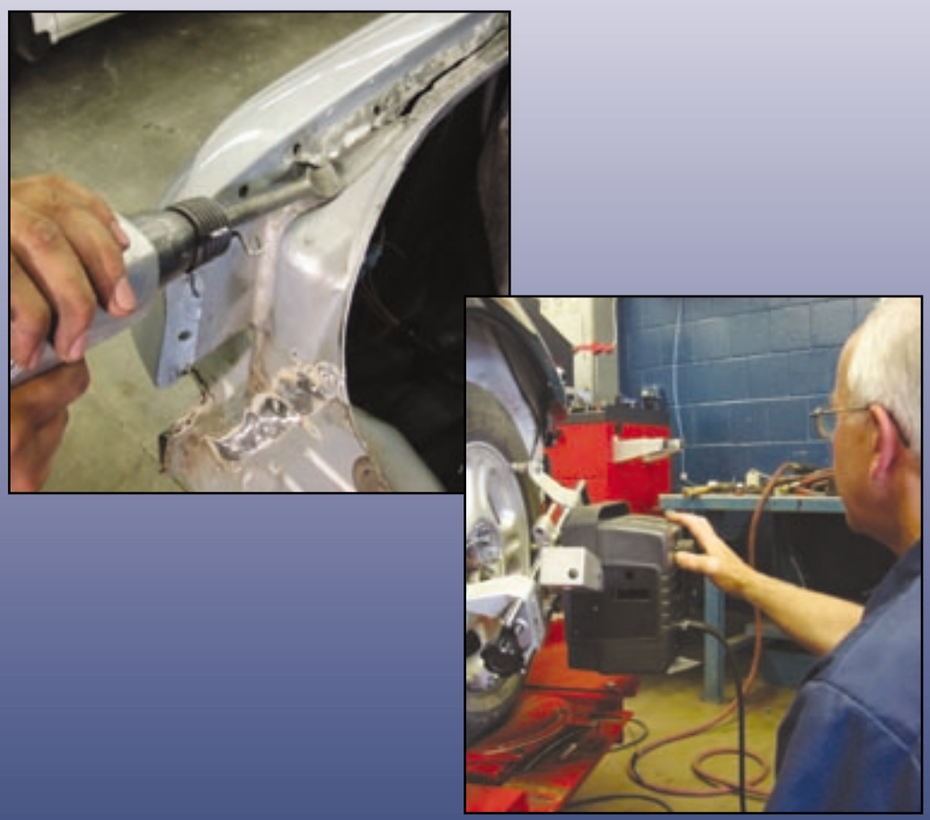
AUTO BODY REPAIR

DINGS AND SCRATCHES



TEACHER'S GUIDE

SHOPWARE®

INTRODUCTION

This Teacher's Guide provides information to help you get the most out of *Dings and Scratches.* The contents in this guide will enable you to prepare your students before using the program and present follow-up activities to reinforce the program's key learning points.

As part of the 12-part series *Auto Body Repair*, *Dings and Scratches* demonstrates the processes and techniques for repairing minor damage to sheet metal, including how to identify and plan repairs, procedures for performing repairs using various tools and supplies, and techniques for metal finishing. After viewing this video and completing some of the learning activities included in this guide, students will be better prepared to properly identify minor damage, and develop and implement a repair plan for mending dents and scratches using the proper tools and techniques. Use *Dings and Scratches* and the accompanying activities provided in this guide to prepare students for the most effective way to approach the repair of minor dents and scratches, and to familiarize them with the tools and techniques they will most often use during the collision repair process.

LEARNING OBJECTIVES

After viewing the program, students will be able to:

- Demonstrate a basic knowledge of sheet metal repair operations and safety procedures.
- Identify the correct tools to use given the task to be performed.
- Explain procedures for identifying damage and plans for repair of sheet metal.
- Explain procedures for repairing sheet metal panels.
- Follow proper procedures to repair damaged sheet metal.

EDUCATIONAL STANDARDS

The primary certifying body for automotive technician training programs is the National Institute for Automotive Service Excellence (ASE). ASE is a non-profit organization established in 1972 by the automotive industry to improve the quality of vehicle repair and service through the voluntary testing and certification of automotive repair technicians. The National Automotive Technicians Education Foundation (NATEF) is a separate non-profit foundation within ASE. The mission of NATEF is to improve the quality of automotive technician training programs nationwide through voluntary certification. The State Departments of Education in all 50 states support ASE/NATEF certification of automotive programs.

National Standards

This program correlates with the Program Certification Standards for Automobile Technician Training Programs from the National Institute for Automotive Service Excellence (ASE) and the National Automotive Technicians Education Foundation (NATEF). The content has been aligned with the following educational standards, which reflect the tasks in the ASE Program Certification Standards for Automobile General Service Technician Programs.

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Outer Body Panel Repairs, Replacements, and Adjustments

- Determine the extent of the direct (primary) and indirect (secondary) damage and the direction of impact; plan the methods and order of repair.
- Remove and replace bolted, riveted, bonded, and welded panels; repair, weld, or replace.
- Check and adjust clearances of front fenders, header, and other panels.
- Restore contours of damaged panel to a surface condition suitable for metal finishing or body filling.
- Apply protective coatings and sealants to restore corrosion protection.
- Repair or replace plastic panels.

Metal Finishing and Body Filling

- Remove paint and other materials from the damaged area of the body panel.
- Cold shrink stretched panel areas to proper contour.
- Metal finish the damaged area of a body panel to eliminate surface irregularities.
- Prepare surface for application of body filler material.
- Mix and apply plastic body filler; shape during curing.
- Sand cured plastic body filler to contour.

2004 Automobile Program Standards, by the National Institute for Automotive Service Excellence (ASE), Copyright 2004 Reprinted with permission.

Language Arts and Communication Standards

According to ASE/NATEF standards, the automobile technician must be proficient in the following Language Arts and Communications related academic skills that are embedded in the occupation. The activities and information presented in this program and accompanying teacher's guide are aligned to the following standards from the National Automotive Technicians Education Foundation from the National Institute for Automotive Service Excellence.

- Request, collect, comprehend, evaluate, and apply oral and written information gathered from customers, associates, and supervisors regarding problem symptoms and potential solutions to problems.
- Identify the purpose for all written and oral communication and then choose the most effective strategies for listening, reading, speaking, and writing to facilitate the communication process.
- Adapt a reading strategy for all written materials, e.g. customer's notes, service manuals, shop manuals, technical bulletins, etc., relevant to problem identification, diagnosis, solution, and repair.
- Use study habits and techniques, i.e. previewing, scanning, skimming, taking notes, etc., when reviewing publications (shop manuals, references, databases, operator's manuals, and text resources) for problem solving, diagnosis, and repair.
- Write clear, concise, complete, and grammatically accurate sentences and paragraphs.
- Write warranty reports and work orders to include information regarding problem resolution and the results of the work performed for the customer or manufacturer.
- Follow all oral/written directions that relate to the task or system under study.

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- Comprehend and apply industry definitions and specifications to diagnose and solve problems in all automotive systems and components of the automobile and light truck.
- Comprehend and use problem-solving techniques and decision trees that are contained in service manuals and databases to determine cause-and-effect relationships.
- Use the service manual to identify the manufacturer's specifications for system parameters, operation, and potential malfunctions.
- Supply clarifying information to customers, associates, parts supplier, and supervisors.

Technology Standards

The activities in this Teacher's Guide were created in compliance with the following *National Education Technology Standards* from the National Education Technology Standards Project. The content has been aligned with the following educational standards and benchmarks.

- Use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
- Use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- Use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
- Use technology tools to enhance learning, increase productivity, and promote creativity.
- Use technology to locate, evaluate, and collect information from a variety of sources.

The *National Education Technology Standards* reprinted with permission from the International Society for Technology Education.

PROGRAM OVERVIEW

The majority of auto body repairs fall under the category of minor damage, specifically dings and scratches. Usually, these damages are too extensive to simply fill in with body filler, but are too small to require a new panel. This video shows how to assess sheet metal damage, plan for and perform minor sheet metal repairs using various tools and supplies, and refinish surfaces. A slide hammer dent puller, weld-on pulling tool, body hammer and dolly, and other tools of the trade are demonstrated. After viewing this program, viewers will be better prepared to properly assess, plan for, and repair minor collision damage using the appropriate tools and techniques.

MAIN TOPICS

Topic 1: Introduction to Sheet Metal Tools and Supplies

This section introduces the hand tools, power tools, and supplies that are used to repair minor dents without drilling holes in the sheet metal. Students will view a brief demonstration of an auto body repair professional using a slide hammer and dent puller with a spot welder.

Topic 2: Preliminary Tasks
This section of the program describes procedures for examining and assessing the extent of damage, determining whether repair or replacement makes the most sense, the importance of devising a repair plan, and safety precautions to take prior to beginning the repair process.

Topic 3: Repairing Damaged Sheet Metal
This section demonstrates the procedures for repairing damaged sheet metal using power tools, hand tools, a stud welder, and auto body supplies. Students will learn the tools and supplies most applicable for each type of repair, and the step-by-step procedures to repair damaged panels that present varying levels of accessibility.

Topic 4: Basic Metal Finishing Techniques
This section of the program demonstrates basic techniques for preparing the surface of metal panels using a variety of supplies and tools. Students will learn safety rules and guidelines for mixing and applying various types of body filler, primer, and putty in preparation for the final finish.

FAST FACTS

- Most auto body repairs fall under the category of minor damage: dents and dings too big to fill, but too small to need a new panel. As a result, the repair of minor panel damage to sheet metal is probably the most common task auto body repair technicians will encounter in collision repair.
- Before beginning any repair, auto body repair technicians must assess the extent of the damage by looking at the point and direction of impact to determine the starting point for the initial inspection. Some damaged parts may have to be removed to determine indirect damage to parts that are not immediately visible. Areas to note are scrapes, buckling, and panel misalignment or movement.
- Drilling holes to pull out dents is no longer an accepted practice for dent repair.
- The repair or replacement of damaged panels is determined by estimating the length of time it will take to remove and replace the damaged panel, plus the cost of a replacement part compared to the amount of time for panel repair.
- For some parts, such as quarter panels, which are welded or bonded into place, removing and installing a replacement is a very time-consuming task, taking 12 to 14 hours plus the cost of the replacement part. Repairing rather than replacing is often a time and money-saving option.
- After examining and assessing the extent of damage, auto body repair technicians should develop a detailed, step-by-step repair plan to identify and organize the parts and supplies needed prior to beginning repairs, and to organize the repair process so no critical steps are overlooked.
- Practice proper safety precautions to avoid bodily injury and property damage. Wear protective safety glasses and have a dust mask handy. Protect undamaged areas adjacent to the repair by covering windows or removing and storing trim and other parts near the repair area.

- Roughing out the damaged areas means to return them as close as possible to the vehicle's original contours by lowering high spots and raising low spots. The area should be within 1/8 of an inch of the original contour *before* applying any body filler.
- Roughing out a damaged area usually requires gaining access to the backside of the damaged panel by removing interior panels and hardware.
- If damage is minor and there is enough access to the back side of the panel, use body hammers, dollies, and spoons.
- If damage is minor and there is limited access to the back panel, use body picks or pry bars.
- If there is no access to the back of the panel, use a spot welder (stud) with a slide hammer and dent puller.
- The surface of the hammer and the dolly should match as closely as possible the original contours of the panel being repaired. Heavier hammers should be used for roughing out while lighter finishing hammers should be used for final shaping.
- When grinding off any remaining paint, weld scale or corrosion in a patch area in preparation for a spot weld, and remove paint from the damaged area and 3 to 4 inches around it while trying to remove as little of the metal as possible.
- Dents should be roughed out within 1/8 inch of the original contour.
- Use of a stud spot welder during minor collision repairs eliminates the need to punch or drill a hole in the panel. Holes destroy rust proofing and provide an ideal spot for corrosion to set in.
- Proper surface preparation is critical to the success of body filler adhesion and includes removal of all dirt, grime, wax, grease, road tar, and any silicone from automotive waxes.

VOCABULARY TERMS

body filler: Durable filler consisting of two parts: the base filler and the hardener, which is used to fill low spots within 1/8 inch or less of the original surface contour.
body filler mixing board: A board made of glass, plastic, or metal used to mix body filler.
body hammer: A tool used for shrinking high areas of sheet metal to level the surface to its original contour by starting with light blows on the edge and working toward the middle.
bumping hammer: A tool used in conjunction with a dinging spoon to work down high spots and bump out low spots during the spring hammering process.
bubbles: Air trapped in body filler caused by excessive stirring.
dent puller: A tool that is used with a slide hammer and a spot welder to pull out a dent when interior trim or body panels prevent access to the backside of the damaged panel.
dinging spoon: A tool used to smooth out and level dings (low spots) when the back of the panel is not easily accessible with a dolly. When held against the ridge of a dent and struck with a hammer, this tool spreads the blow over a large area.
disc sander: A tool that uses sandpaper to grind off remaining paint, weld scale, or corrosion in a patch area.
dolly: A large chunk of steel with a slightly curved flat side to pound against.
glazing putty: Fine filler consisting of two parts: the base filler and the hardener, which is used to fill in scratches that cannot be buffed out.

hammer-off-dolly: A technique for roughing out a large buckle by placing the dolly under a low spot while striking an adjacent high spot with the hammer. This action causes the hammer to drive the high spot down, while the rebounding dolly drives the low spot up without stretching the metal.
hammer-on-dolly: A technique for straightening metal by holding the dolly directly behind the high spot, and firmly pressing it against the metal while striking the opposite side with light hammer blows. This technique requires that both the hammer head and dolly surface match the desired shape of the panel. If the area is flat, a flat dolly and hammer should be used. If the area is curved, both the dolly and hammer head should match the curve as closely as possible.
pick: A tool that is often inserted into an existing hole to push or pry up metal in areas that can't be reached with spoons; often used in place of a pry bar.
polyfiller: Liquid body filler consisting of two parts: the base filler and the hardener, which is sprayed on to fill in all of the pinholes and minute scratches for which body filler or glazing putty is not suitable.
primer: A material that is applied over bare metal to promote the adhesion of surfacer material. Failure to prime bare metal areas often results in the paint peeling off later.
pry bar: A tool that is often inserted into an existing hole to push or pry up metal in areas where there is limited access to the back panel or where the area cannot be reached with spoons; often used in place of a pick.
rough out: The process of lowering high spots and raising low spots to return them as close as possible to the vehicle's original contours.
shrinking hammer: A tool used to shrink metal in a raised area to restore the original contour.
slide hammer and dent puller: A metal rod with a tool at one end, and a heavy weight that slides on the rod to pull or push the tool. Used with a spot welder to pull out a dent.
spring hammering: A dent repair technique that uses a dinging spoon held firmly against the back of a ridge or crease, while a bumping hammer is used to hit the surface of the ridge to work down high spots and bump out low spots.
stud spot welder: A welding gun that welds studs (pins) onto the surface of the dented metal panel; used with a slide hammer that attaches to the studs and pulls out the dent.
surfacer: A material that is used to fill in the fine grooves left from sanding, which promotes the adhesion of the final finish.
weld-on pulling tool: A tool that is a variation of the slide hammer and dent puller (two tools in one). The slide hammer part of the tool is used to pull out the dent after the tip of the weld gun is actually welded to the dent. This tool eliminates drilling holes in panels to pull dents.

PRE-PROGRAM DISCUSSION QUESTIONS

1. What are some typical casues of minor panel damage to sheet metal on a car or truck?
2. Have you ever painted a room? If so, describe the major steps in the painting process.
3. How do the steps for painting a room relate to the repair of minor collision damage?
4. What do you think might happen if a critical step is missed during the repair process?
5. Today, the repair of minor collision damage no longer includes drilling holes to pull out dents. Why do you think this is the case?

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POST-PROGRAM DISCUSSION QUESTIONS

1. Now that you have seen the *Dings and Scratches* video, why do you think an auto body repair professional should rough out a damaged area to within 1/8 of an inch of the original contour before applying any body filler?
2. After inspecting a damaged quarter panel on a vehicle, an auto body repair technician decides to repair the quarter panel rather than replace it. What factors may have influenced the technician's decision?
3. When straightening metal, why should auto body repair technicians start with a light touch–small taps, light pressure–and work up to harder blows and pressure if needed?
4. What can happen if too much or too little hardener is added to the plastic filler and then applied to a damaged panel?
5. Why might an auto body repair professional use a body pick or pry bar rather than a slide hammer and dent puller?

GROUP ACTIVITIES

What's My Line?

In the video, participants learn about different procedures and techniques to repair minor dings and scratches using specific tools and supplies. Divide the class into groups of three. Assign one tool or supply to each group (e.g., body filler, body hammer, dent puller, dinging spoon, dolly, glazing putty, primer, slide hammer and dent puller, stud spot welder, weld-on pulling tool). Instruct each group to research and document the characteristics of the assigned tool or supply. Characteristics to consider include appearance, purpose, when the tool or supply is used, procedures or techniques for use, safety considerations, etc. Participants may use the Internet, reference the *Dings and Scratches* video, consult the instructor, etc. to gather information. After all information is gathered, play *What's My Line?* as follows:

One three-person group forms a panel in the front of the room; panel members are referred to as #1, #2, and #3. During a defined period of time, the class asks the panel questions that require a YES or NO response to try to determine which tool or supply the panel represents. For example, if the panel has assumed the identity of hardener, the class could ask:

- Are you used to pull out a dent? (No)
- Do you play a part in the surface preparation process? (Yes)
- Are you used to apply finishing material? (No)
- Do you come in a can? (No)
- Do you come in a tube? (Yes)
- Are you always used with other compatible material? (Yes)

After the time is up, the instructor asks participants to write down the identity (tool or supply) of the panel before calling upon a volunteer to reveal his/her guess. After correctly revealing the identity of the panel, another three-person group forms the next panel. The game is played

until all students have appeared on a panel. Note: The instructor will know the identity of each panel and preside over the questioning period, guiding students when necessary.

Tool Time

Divide the class into four groups, and provide them with art supplies (pencils, magic markers, scissors, glue, etc.) and poster board. Instruct students to draw two columns, one being twice as wide as the other, and then to divide the columns into twelve rows. The first row of the left column will be labeled "Tool / Supply" and the first row of the right column will be labeled "Function / When To Use". Instruct students to draw the tools/supplies used for minor collision repair in the left column (list provided below), and insert a brief description in the right column of the function of the tool/supply and when it should be used.

Tools / Supplies: Body Hammer; Bumping Hammer; Dent Puller; Dinging Spoon; Dolly; Pick; Pry Bar; Shrinking Hammer; Slide Hammer and Dent Puller; Stud Spot Welder; Weld-on Pulling Tool.

Example:

Tool/Supply	Function/When to Use
(Drawing of stud spot welder)	• A welding gun that welds studs (pins) onto the surface of the dented metal panel • Used with a slide hammer that attaches to the studs and pulls out the dent. • Used when there is no access to the back of the panel.

Friendly Feud

The video presents valuable information about repairing minor damage to sheet metal, including tools and supplies, preliminary tasks, and repair and finishing procedures and techniques. Divide the class into two teams, have them choose a team name, and provide each team with ten index cards. Instruct the students to write one repair-related question on one side of the card, and the corresponding answer on the back. Collect the completed cards from each team and place them in two separate boxes (one box for each team).

Instruct each team to choose five players to form a panel. Appoint an audience member to keep score during the game. Each player will take turns choosing a question submitted by the other team from the box. The first player on one team will give the instructor the chosen card. The instructor will read the question and the player will attempt to answer it. If a player answers correctly, a point is awarded to his/her team. Likewise, if a player answers incorrectly, a point is subtracted. Any audience member may then attempt to answer questions that were answered incorrectly, but no points will be awarded. The instructor will announce the winner after all questions have been read.

INDIVIDUAL STUDENT PROJECTS

Prepare a Scavenger Hunt List

Your car has just suffered minor damage to the left quarter panel. Fortunately, there is enough access to the back side of the panel to make repairs. You have determined that repair is more economical than replacement. You have solicited the help of Boy Scouts to conduct a scavenger hunt in order to gather the tools and supplies needed to rough out the damaged area and prepare the surface of the panel in preparation for the final finish. You must prepare a scavenger hunt list for the Scouts. Based on the clues provided in this description, create a comprehensive list of tools and supplies that you will need to repair the minor damage. You may consult several sources to help you create the list, such as the *Dings and Scratches* video, the Internet, collision repair magazines, etc.

Top Ten

After roughing out the damaged areas and returning them as close as possible to the vehicle's original contours, the second phase in the minor collision repair process is preparing the surface of the metal panel in preparation for the final finish. Surfacing material must be applied using a variety of tools and supplies, as well as specific techniques for the given material. Prepare a list of *The Top Ten Things Auto Body Repair Technicians Should Do During Metal Surface Preparation*. Think about safety rules, as well as guidelines for mixing and applying materials such as body filler, primer, and putty. Step #10 should be the first step in the surface preparation process; Step # 9 should be the second step, and so forth. Step #10 is provided below to get you started:

#10. To remove all dirt, grime, wax, grease, road tar and any silicone from automotive waxes, the auto body repair technician should clean the surface using soap and water, and then dry the area with a clean cloth.

Preliminary Steps Pamphlet

Conscientious auto body repair technicians know the four Ps of approaching repairs–**P**rior **P**lanning **P**revents **P**anic! The *Dings and Scratches* video discussed certain procedures that must be performed prior to beginning the repair process. Prepare a checklist of tasks auto body repair technicians should perform before actually beginning minor repairs. After finalizing the list, design a pamphlet to accommodate the checklist. Consult the *Dings and Scratches* video, the Internet, fellow classmates, and any other sources that you have available. Categorize the tasks by similarities. Some areas to consider include: Damage Assessment, Course of Action, Planning, and Safety. Include checkboxes after each task and jazzy graphics or drawings. Be prepared to share your brochure with the class.

INTERNET ACTIVITIES

Tech Tips

Many auto body repair web sites include links to Web pages that offer tips and tricks on various subjects. Visit Web sites that contain tips about dent removal and scratch repair (you may want to start at www.metalshapers.org). Jot down five good tips that fellow classmates may find interesting or helpful. Students will then share their tips with the class, and vote on the most interesting or helpful tip presented.

Discussion Forums

Visit www.autobodyonline.com and enter the discussion forums by clicking the "Discussion" tab in the upper left corner of the Web page. Post a question about minor collision repair. Ask about techniques that experienced auto body professionals have successfully used in the past. Also, review the other posts within the forums and see if you can gather any other information about preliminary steps, safety considerations, proper procedures, surface preparation, etc. After a week, copy all your responses, as well as any other posts you have seen that are relevant, into a word processing document. Then answer the following questions: What have you learned as a result of the answers you have received to your post? What have you learned from reading other posts? Did any of the responses conflict with one another? If so, what issues did they raise?

ASSESSMENT QUESTIONS

Q: Technician A says that the hammer-off-dolly method to rough out a large buckle is performed by placing the dolly under a low spot while the hammer is applied to a high spot just to the side of the dolly. Technician B says that the hammer-off-dolly technique raises the low spot and lowers the high spot simultaneously without stretching the metal. Who is correct?

(a) Technician A
(b) Technician B
(c) Both A and B
(d) Neither A nor B

A: (c)

Feedback: The hammer-off-dolly method to rough out a large buckle is performed by placing the dolly under a low spot while the hammer is applied to a high spot just to the side of the dolly. This technique raises the low spot and lowers the high spot simultaneously without stretching the metal, which is why the hammer-off-dolly method works well to rough out a large buckle.

Q: Which one of the following materials is used to fill surface pinholes and deep scratches that cannot be buffed out?

(a) Glazing putty
(b) Sprayable polyfiller
(c) Body filler
(d) Both A & B

A: (d)
Feedback: Glazing putty is used to fill fine pinholes. Sprayable polyfiller is used to fill in pinholes and minute scratches not suitable for body filler or glazing putty.

Q. Which hand tool is used in conjunction with a dinging spoon to work down high spots and bump out low spots during the spring hammering process?

(a) Dent puller
(b) Bumping hammer
(c) Slide hammer
(d) Stud spot welder

A: (b)
Feedback: The spring hammering process is a dent repair technique that uses a dinging spoon held firmly against the back of a ridge or crease, while a bumping hammer is used to hit the surface of the ridge to work down high spots and bump out low spots.

Q: When mixing filler and hardener together on the filler mixing board, why should auto body repair technicians use a back and forth scraping motion rather than stirring the mixture?
A: Stirring the mixture causes air bubbles to form.
Feedback: When combining filler and hardener, mix the filler and hardener together using a back and forth scraping motion. Stirring the mixture will cause air bubbles to form. Air in the compound will result in the filler curing unevenly.

Q: Auto body repair technicians should only mix body filler and hardener compounds made by the same manufacturer. *(True or False)*
A: True
Feedback: Body filler should only be mixed with hardener that is made by the same manufacturer to ensure compatibility of both compounds.

Q: Technician A says that a stud spot welder and studs should be used in conjunction with a slide hammer and dent puller to pull out a dent when there is no access to the back of the panel. Technician B says that when using a stud spot welder, it is not necessary to remove paint before welding the stud to the dent. Who is correct?

(a) Technician A
(b) Technician B
(c) Both A and B
(d) Neither A nor B

A: (a)
Feedback: A stud spot welder and studs are used in conjunction with a slide hammer and dent puller to pull out a dent when there is no access to the back of the panel. However, before welding the stud to the dent, you must remove the paint in the damaged area.

Q: A(n) _____helps auto body repair professionals to organize both the parts and supplies needed for an upcoming repair and the process that follows so no critical steps are missed.
A: repair plan
Feedback: A repair plan is essential to a successful repair job.

Q: Which hand tool should be used to push or pry up metal in areas that cannot be reached with spoons?
A: A pick
Feedback: Picks can often fit through existing holes, eliminating the need to remove interior trim or panels to reach the damaged area.

Q: Why is primer applied to bare metal before applying any other surface materials?
A: Primer promotes adhesion of surface materials.
Feedback: If bare metal is showing, it must be primed before surface materials, such as surfacer or paint, are applied. Primer promotes adhesion of the surface materials. If bare metal areas are not primed, there is the risk of paint peeling off later.

Q: A damaged area should be within 1/4 of an inch of the original contour before applying any body filler. *(True or False)*
A: False
Feedback: Roughing out the damaged areas is the process of returning them as close as possible to the vehicle's original contours by lowering high spots and raising low spots. The area should be within 1/8 of an inch of the original contour before applying any body filler.

ADDITIONAL RESOURCES

WEB SITES

Auto Body Online
www.autobodyonline.com

Auto Body P.I.
www.autopi.com/frame.htm

Auto Body Pro
www.autobodypro.com

Auto Body Tool Mart Repair and Restoration Tutorials
www.autobodytoolmart.com/restorations.html

Automotive Body Repair News
www.abrn.com/abrn

Auto Glossary
www.autoglossary.com

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Automotive Services Association®
www.asashop.org

Automotive Youth Educational Systems (AYES)
www.ayes.org/index.asp

Collision Repair Industry: Insight
http://www.collision-insight.com

How Stuff Works—Auto Stuff Page
auto.howstuffworks.com

I-car
www.i-car.com

Metalshapers Association
http://www.metalshapers.org

National Automotive Service Task Force
www.nastf.org

National Automotive Technicians Education Foundation
www.natef.org

Society of Collision Repair Specialists
www.scrs.com

Tektips—Auto Body Pro Website
www.autobodypro.com/tektips.htm

BOOKS

Duffy, James E. *I-CAR Professional Automotive Collision Repair*. Albany, NY: Delmar Thomson Learning, 2001. ISBN: 0766813991

Duffy, James E. *Auto Body Repair Technology, 4th Edition*. Clifton Park, NY: Thomson/Delmar Learning, 2003. ISBN: 0766862747

Killingsworth, Jeff, Eric Godfrey, and John H. Haynes. *The Haynes Suspension, Steering And Driveline Manual*. Newbury Park, CA: Hayes North America, 1998. ISBN: 1563922932

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OTHER PRODUCTS

Automotive Technicians, VHS/DVD, Cambridge Educational
Sponsored by the National Automotive Technicians Education Foundation (NATEF), this program explores automobile repair and collision repair. NATEF works closely with Automotive Service Excellent (ASE), the nation's only industry-wide certification program for automotive technicians. Technicians with a sound education have a choice of career avenues. Aside from fixing cars and trucks, they can become service managers, service engineers, automotive writers, or even auto technology teachers.
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